instruction manual

Sorensen & Company, inc.

Richards Avenue

South Norwalk, Conn.

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OFFICIAL RECORDS STATION
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FACILITIES JAN 4 1963

MA HI CURRENT

NOBATRONS

"MA" HIGH CURRENT NOBATRONS

TABLE OF CONTENTS

Page

I. General Information 3

II. Specifications 4

III. Installation & Operation 7

IV. Principle of Operation 10

V. Maintenance & Repair 14

Condensed Catalog

SORENSEN/A UNIT OF RAYTHEON, Richards Ave., So. Norwalk, Conn.
SB14-2096B
6/58

GENERAL INFORMATION

PLEASE READ THIS MANUAL. We think it will help you to obtain the maximum performance from your new Sorensen instrument.

SHIPPING DAMAGE

Sometimes instruments are damaged in transit. We strongly suggest that you inspect and test your instrument as soon as you receive it. If the instrument is damaged or if it fails to operate properly, you should ask the carrier to inspect the shipment. The Carrier's claim agent will prepare a report of damage which you should send to us. We will then tell you how to have the instrument repaired or replaced.

SERVICE INFORMATION

If you have any questions about the operation, repair, or servicing of a Sorensen instrument, please contact our local representatives. (A list of representatives is included with this manual.) If it is more convenient you may contact us directly at the Service Department, Sorensen, Richards Avenue, South Norwalk, Connecticut.

IMPORTANT

BE SURE TO INCLUDE THE MODEL & SERIAL NUMBER IN ALL CORRESPONDENCE CONCERNING THIS INSTRUMENT. WITHOUT THIS INFORMATION WE MAY NOT BE ABLE TO GIVE YOU PROMPT AND ACCURATE SERVICE.

RETURNS TO THE FACTORY

Should you decide to return an instrument to us for repair, please contact us for authorization to make shipment. We have a number of local service facilities in the United States and Canada which are equipped and staffed to provide you with fast, efficient service. For this reason, we reserve the right to refuse unauthorized shipments to our plant.

WARRANTY

This instrument is warranted by Sorensen/Unit of Raytheon, to be free from defects in material and workmanship. Our obligation under the warranty is limited to servicing the instrument and replacing defective parts* when the instrument is returned to the factory with transportation charges prepaid. No other warranties may be implied. The period of warranty is one year after the delivery of the instrument to the original purchaser. Defects caused by improper operating conditions, accidents, misuse, negligence, and the alteration or removal of the nameplate, will void the warranty.

* With the exception of tubes and fuses.

II. SPECIFICATIONS

The MA High Current Nobatron is a tubeless high current, DC, power supply designed to provide a continuously adjustable well-regulated output over certain voltage ranges. The MA High Current Nobatron is designed to permit sensing at the load point so as to compensate for the voltage drop in the leads to the load.

The Specifications for MA High Current Nobatrons are listed below in table form. Special notes with further details follow on the next two pages.

MODEL	MA12-200	MA28-125	MA28-250	MA28-500
Input Power	208, 230 or 460VAC ± 10%, 60 cycles, 3 phase 3 wire.			
Input Current	18 Amps	22 Amps	44 Amps	88 Amps
Output Voltage Adjustment	9-18VDC	18-36VDC	18-36VDC	18-36VDC
Regulation Accuracy*	±0.2% Line ±0.5% Load	±0.2% Line ±0.2% Load		
Ripple (Maximum)	1% RMS at Nominal Output Voltage			
Response Time	0.1 second (10% line change or 50% load change)			
Output Current*	0-200 Amps	0-125 Amps	0-250 Amps	0-500 Amps
Ambient Temperature Range*	15°C (59°C) to 35°C. (95°F).			
Weight (Net)	230 Lbs.	225 Lbs.	500 Lbs.	600 Lbs.
Dimensions (Self-Contained)	19" 21 1/4" high 15" deep	19" 21 1/4" high 15" deep	25 1/4 wide 34" high 23" deep	25 1/4 wide 42" high 23" deep
Input Connections	Terminal Board Rear of Unit		Terminal Board Side of Unit	
Output Connections	Terminal Board Rear of Unit		Terminal Board Side of Unit	
Protective Connections	Short Circuits	Fuse	Klixon	Fuse	Fuse
	Fuse 2 Amp	Protects Blowers and Transformers T5 & T6.			
	Thermostats & Relay	Blower Failure			
Meters	Voltmeter and Ammeter Standard Equipment			

* See Special note on following pages.

SPECIFICATIONS--SPECIAL NOTES

Regulation Accuracy

1. 28VDC Models
   The regulation accuracy for line changes is defined as ±0.2% against a 10% line change at 28VDC and a fixed load current. The regulation accuracy for load changes is defined as ±0.2% against load changes from no load current to full current at 28VDC output and a fixed input line voltage. Note that the regulation accuracy applies to line or load separately. If line and load are both changed, the total regulation accuracy becomes ±0.4% maximum. However, a typical unit will have ±0.1% regulation at 28VDC for any combination of a 10% line change and a 50% load current change.

2. 12VDC Models
   ±0.2% regulation accuracy for line changes
   ±0.5% regulation accuracy for load changes
   ±0.25% regulation accuracy for combined change of 50% load and 10% line.

RESPONSE TIME

Response time is stated as 0.1 second for a 10% line change or a 50% load change. Response time is defined as the time for the output of the Nobatron to effect a 63% recovery from the maximum deviated value.

AMBIENT TEMPERATURE RANGE

If operation above 35°C (95°F) is attempted, the life of various components may be reduced. In some cases, operation at reduced loads is possible at higher or lower ambients. This is at the discretion and responsibility of the user.

Below 15°C(59°C) a higher initial ripple may be noticed. This will decrease, however, as the instrument warms up, but may still be above 1% RMS at these low ambients.

After allowing thirty minutes for warm-up, drift at a fixed ambient should not be more than 0.5% for any 24-hour period.

OVERCURRENT PROTECTION

These instruments are equipped with overcurrent devices that protect them from short circuit failure. The Models MA12-200, MA28-250 and MA28-500 employ a fuse for this purpose. The Model MA28-125 employs a Klixon circuit breaker. Curves showing the permissible current in the main rectifier vs. the fuse or Klixon blow time and short circuit current are shown on the following page.

III. INSTALLATION & OPERATION

Models MA12-200 and MA28-125 may be supplied as self-contained units suitable for bench top operation, or equipped with side brackets for relay rack installation. A change later from bench top to rack mounting or vice-versa can be easily accomplished. To purchase the parts needed for such a change, contact our local representative or our Service Department.

Models MA28-250 and MA28-500 are supplied as self-contained floor models. Castors are optional but can be supplied with both models.

INPUT

On Models MA12-200 and MA28-125 the input power is connected to the terminal board located at the rear (within) of the unit. It is necessary to remove the rear cover to make the connections and also to carry the input lines through the grommet hole provided in the rear cover.

The input current (each line) for each model is listed under Specifications, Section II. The proper wire size for the input lines should be selected after consulting the local wiring codes on the subject.

These instruments are not supplied with an input line ON-OFF switch, therefore, an external safety switch or magnetic circuit breaker should be added by the purchaser.

Models MA28-250 may be supplied with or without an input contractor. This contractor is located on the side of the unit and input power is connected directly to contactor. On models supplied without the contactor input power connections are made to the input terminal board located on the side of the unit.

IMPORTANT: These instruments have to be adjusted before shipment to accept an input line of 208 volts ±10%. In the event it is desired to connect the unit to 230 volts input, please refer to the Supplementary Service Information Sheets A14-4442 for MA28-250, MA28-500 and A14-4443 for MA28-125, MA12-200 included with this manual.

The terminal marked "G" at the input terminals is connected to the chassis and should be connected to the electrical system ground by a wire of the same size as the other input lines.

COOLING

A blower is used to provide forced air cooling. CARE SHOULD BE TAKEN TO INSURE THAT THE AIR FLOW IS NOT RESTRICTED as excessive heat would cause serious damage to various components, particularly the silicon rectifiers.

IMPORTANT: SEE INSTRUCTIONS UNDER MAINTENANCE PAGE 13 FOR CLEANING THE AIR FILTER AND LUBRICATING THE BLOWER MOTOR.

OUTPUT

Models MA12-200 & MA28-125
The output power connections should be made through the grommets on the left rear side of the unit to the terminal board located within the unit on that side. The connections should be made to the two large screw-type lugs on the phenolic terminal board. Number 4 wire size is recommended for the output cable. Neither output terminal is connected to ground; however, either output may be grounded.

Models MA28-250 and MA28-500
The output power connections should be made to the output terminal board located on the side of the unit. Number 00 size wire is recommended for the model MA28-250, and number 000 size wire recommended for the model MA28-500.

CONTROLS

Output Voltage Adjustment: The output voltage is continuously adjustable between 9 and 18VDC for 12 volt units, and 18-36VDC on 28 volt units. These adjustments are made by means of a voltage control located on the front panel.

PROTECTIVE DEVICES

Fuse The fuse located on the front panel only protects the blower and the auxiliary power supply.

Overheating In the event of overheating by reason of blower failure or restriction of air flow, the thermal circuit breakers S1 or S2 will open the relay K1. This relay in turn will cause the output voltage to drop to a safe setting. Breakers S1 and S2 reset automatically.

Overcurrent Some models employ a thermal circuit breaker (manual reset) which is located on the front panel. Other models employ a fuse located within the unit. Refer to the schematic for details on the overcurrent protection employed in this unit. The time curve for the circuit breaker under various load conditions is shown on page 6.

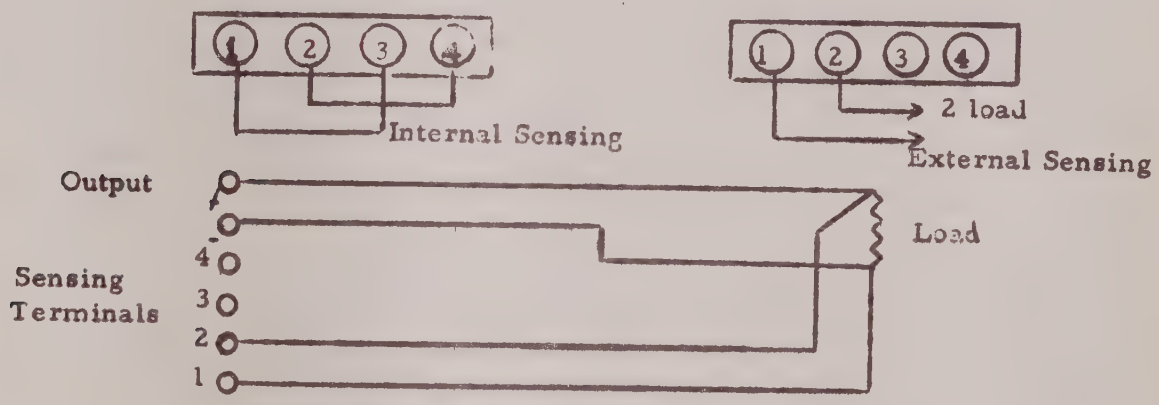
REMOTE SENSING

A useful feature of these instruments is external sensing; that is, sensing of the output voltage at a point quite remote from the unit.

The deterioration of regulation under remote sensing conditions is about 0.1% for every 0.1 ohm of resistance in the sensing leads.

On the models MA12-200 and MA28-125 the sensing is on a terminal board located within the unit on the upper left side when looking from the rear. The arrangement of jumpers for internal and external sensing is shown below.

On the Models MA28-250 and MA28-500 the sensing connections are made at the input-output terminal board.



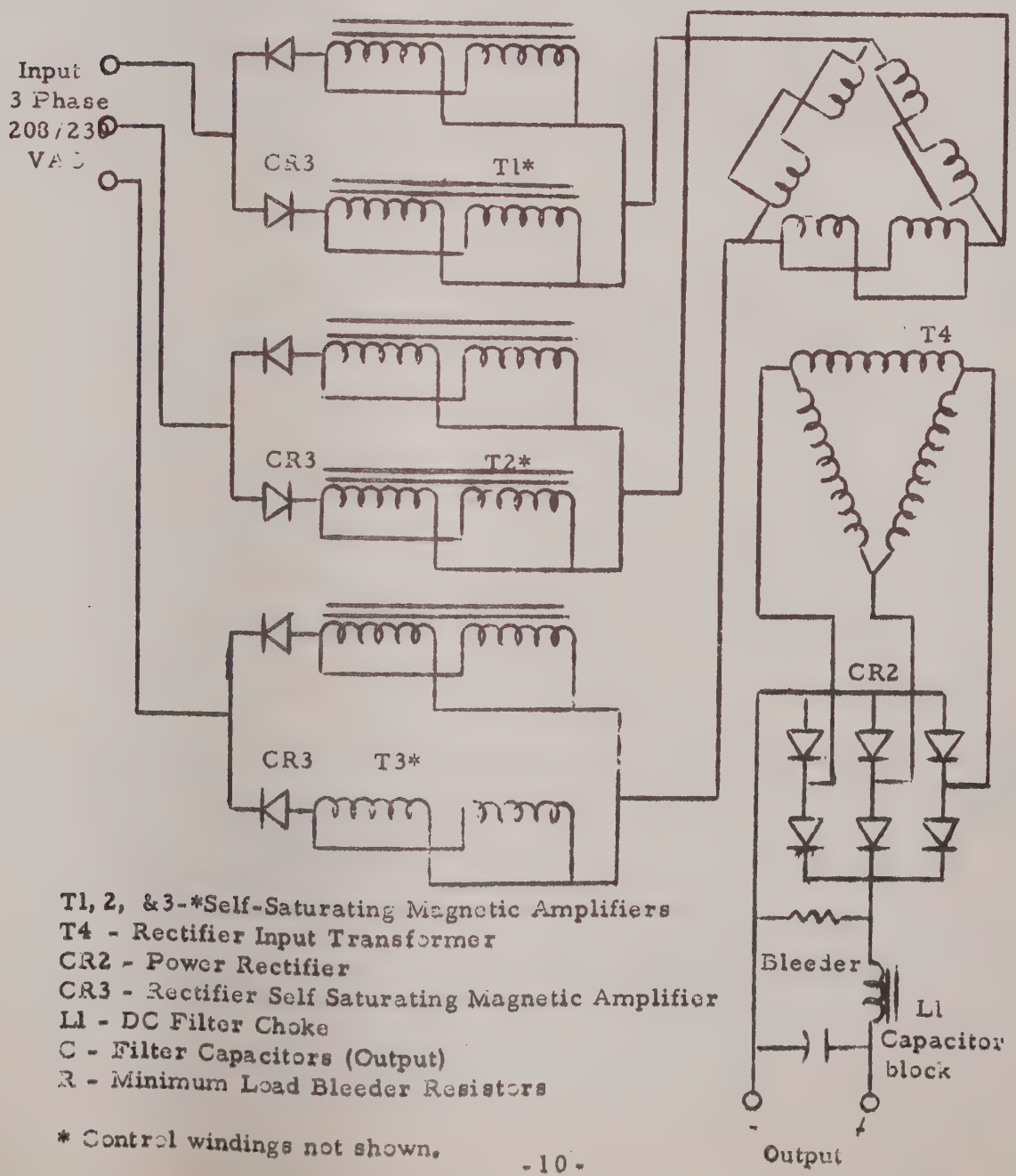
Typical external sensing arrangement

IV. PRINCIPLE OF OPERATION

The operation of your MA High Current Nobatron can best be understood by referring to the exact schematic of your instrument. Such schematics are furnished with each unit.

Sorensen MA High Current Nobatrons employ power, self-saturating magnetic amplifiers followed by a filter section, together with a transistorized control or "power reference" circuit.

Power & Filter Circuit



T1, 2, &3-*Self-Saturating Magnetic Amplifiers
T4 - Rectifier Input Transformer
CR2 - Power Rectifier
CR3 - Rectifier Self Saturating Magnetic Amplifier
L1 - DC Filter Choke
C - Filter Capacitors (Output)
R - Minimum Load Bleeder Resistors

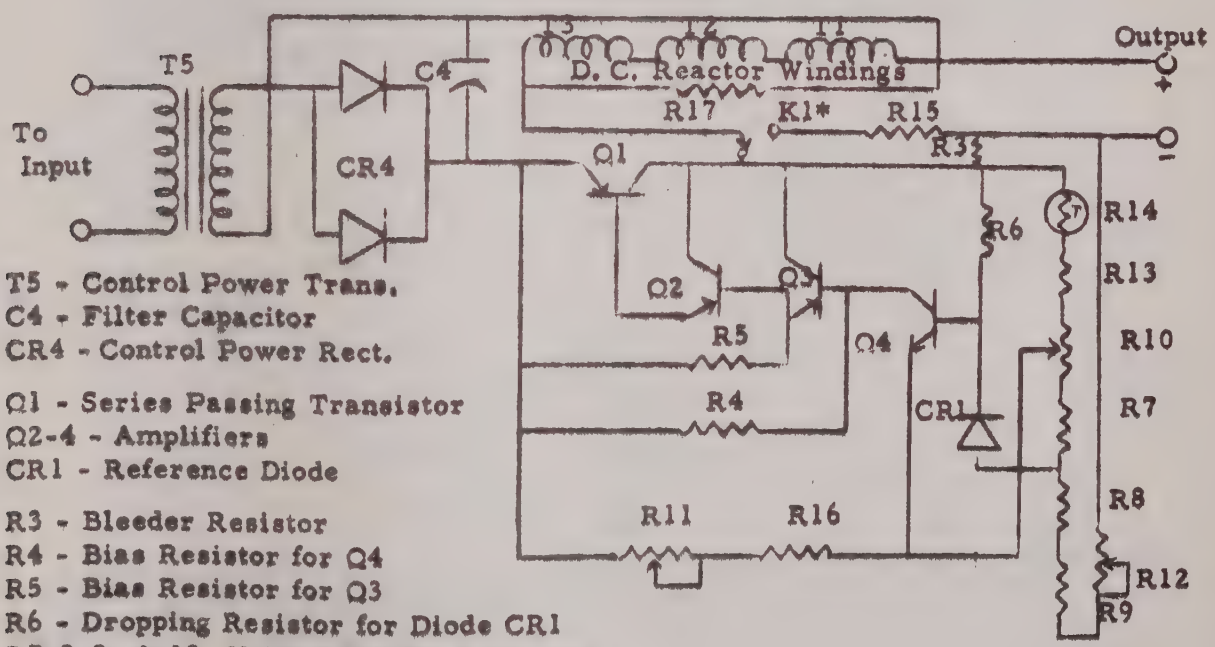
* Control windings not shown.

Power & Filter Circuit--Cont'd

A detailed explanation of the theory of the magnetic amplifier is beyond the scope of this manual. In simple terms, however, the AC coils on the reactors may be considered to act as "gates" which open at some time during the half-cycle in which the rectifiers CR3 allow conduction. Until the gate opens, no current flows. After the gate opens, current flows and is restricted only by the impedance of the load circuit. The average current, and hence the voltage is controlled by the fraction of the half-cycle period that the gate is open. For example, if the input voltage is reduced, the current flow during the conduction period will be reduced. Therefore, the gate must be opened earlier to maintain the same output voltage.

Opening the gate is controlled by the current in the DC windings of the magnetic amplifiers, T1-3. Adding control ampere turns with the same polarity as the power ampere turns, as determined by the rectifier CR3, will increase the output, and conversely reducing the control ampere turns will decrease the output.

Control Circuit



T5 - Control Power Trans.
C4 - Filter Capacitor
CR4 - Control Power Rect.

Q1 - Series Passing Transistor
Q2-4 - Amplifiers
CR1 - Reference Diode

R3 - Bleeder Resistor
R4 - Bias Resistor for Q4
R5 - Bias Resistor for Q3
R6 - Dropping Resistor for Diode CR1
R7, 8, 9, & 13 - Voltage Divider Resistors
R10 - Reference set and centering Resistor
R11 & 16 - Line Compensating Potentiometer & Resistor.
R12 - Voltage Adj. Pot (F. P.)
R14 - Temp. Comp. Resistor
R17 - Anti surge Resistor

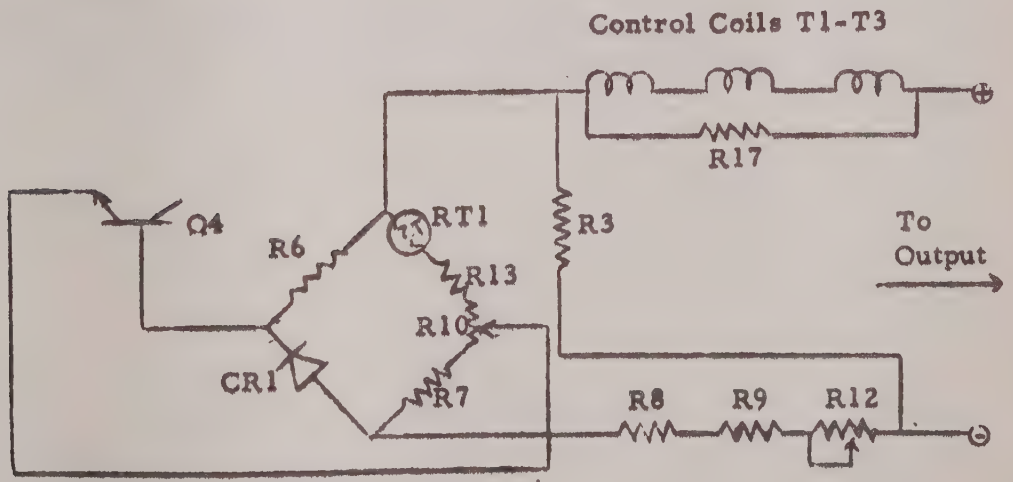
* Relay shown in operating position.

PRINCIPLE OF OPERATION--Cont'd

Control Circuit--Cont'd

The Control Circuit is a "Power Reference" consisting of a series transistor voltage regulator. The output of the instrument is compared directly to the reference through the control windings of the magnetic amplifiers, T1, 2, &3. Any change in the output voltage due to line or load change produces an "error" voltage across the control windings. This voltage causes a current flow which changes the firing point of the magnetic amplifiers, thus correcting for the change in output. The degree of correction, and hence the regulation accuracy, is determined by the gain of the magnetic amplifier core, the windings, and the regulation accuracy of the "power reference."

1. Reference Source--The silicon diode, CR1, is operated in its zener or reverse current region. Under this condition, a constant voltage will appear at the terminals of the diode as the current varies within certain limits. CR1 is one arm of a bridge circuit consisting of R6, R7, R10, R13, and RT1 arranged so that any change in the output voltage will result in change in the emitter circuit of Q4 (see below).



2. Amplifying Transistors--The signal between the base and emitter of the first transistor Q4 is amplified by transistors Q3 and Q2 and applied to the power transistor Q1.

Control Circuit--Cont'd

3. Power Transistor-- The Power Transistor Q1 regulates the output of the "power reference" by the total voltage drop from the emitter to the collector. In order to reduce the power loss in this transistor, its total voltage supply, which is connected to the emitter, is the sum of the output of the Nobatron and a voltage from the auxiliary power supply. The auxiliary supply circuits consists of T5, CR4 and C4. This supply is connected to the input power line.

   Since the reference voltage (collector of Q3) is connected to the output of the Nobatron, in series with the control coil, the voltage drop from the reference to the output is less than a volt. Therefore, the total emitter to collector voltage is the total of this small coil drop plus the auxiliary power supply voltage (the voltage across C4).

4. Temperature Compensation--RT1 is a Negative Temperature Coefficient resistor which is used to counter balance the positive coefficient of the remainder of the circuit.

5. Line Compensation--Compensation for input line voltage changes is accomplished in the "power reference" by applying voltage from the auxiliary power supply to the emitter of Q4 through resistors R11 and R16.

V. MAINTENANCE & REPAIR

Maintenance

During normal life these Nobatrons require no maintenance other than the care afforded similar electronic equipment.

1. Cleaning Air Filter--Since the life of the silicon rectifiers can be considerably reduced by restricting the air flow, it is recommended that the air filter be removed and cleaned at frequent intervals, depending on the location of the Nobatron and the amount of foreign matter in the air.

2. Blower Motor Lubrication--The blower motor should be lubricated at least each 1000 hours of operation with SAE #10 (light) oil. Two oil cups are provided on the motor for this purpose.

   To oil the motor, it is necessary to remove the blower and motor assembly. This is a simple operation. Simply snap the blower retaining rod out of the notches in the blower housing and swing it out of the way. Then pull the assembly out of the Nobatron after disconnecting the blower line cord.

   In the event it becomes necessary to clean the blower housing, it will become necessary to remove the housing from the wheels and motor. To do this, set the whole assembly face down on a table with the discharge duct openings facing down. Grasp the two housings at the same time and twist them in the direction of the arrow marked "off." You will find that the housings will unlock from the motor and wheel assembly, allowing this assembly to stand on the motor air duct as its support. Slip the two housings carefully off of the blower wheels. These housings can readily be put in a dish-pan and cleaned inside and out. You will find very little grease on the blower wheels. These can be cleaned by brushing lightly. Be careful in handling this unit. Do not bend the wheels so they will not run true.

Spare Parts

All components used in these Nobatrons are of a good commercial grade and can be expected to give you a reasonably long period of trouble-free service. As the age of your instrument increases, some components are likely to deteriorate; we therefore suggest that you note those items asterisked on the Replacement Parts List which we recommend be kept on hand.

In the event it becomes necessary to replace any part, we strongly suggest that the replacement part be of the same value as the original. Substitute parts should not be used unless we assure you that the substitute will not impair the performance of your Nobatron.

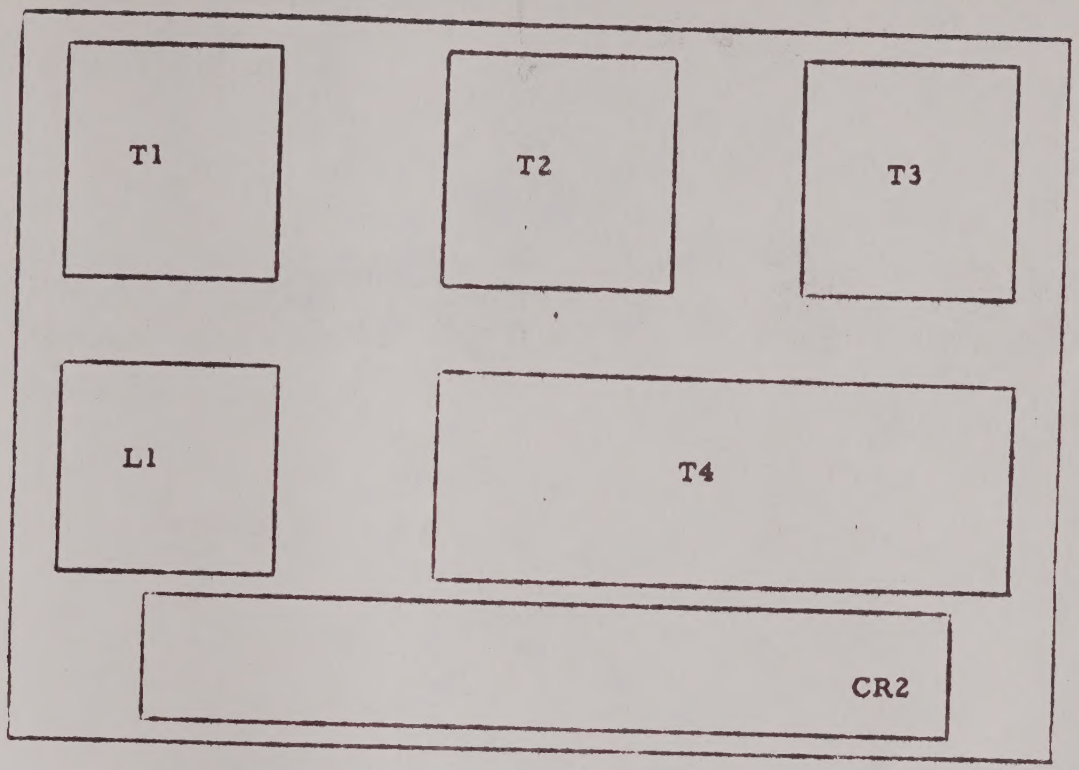
MAINTENANCE & REPAIR (CONT.)

Repair

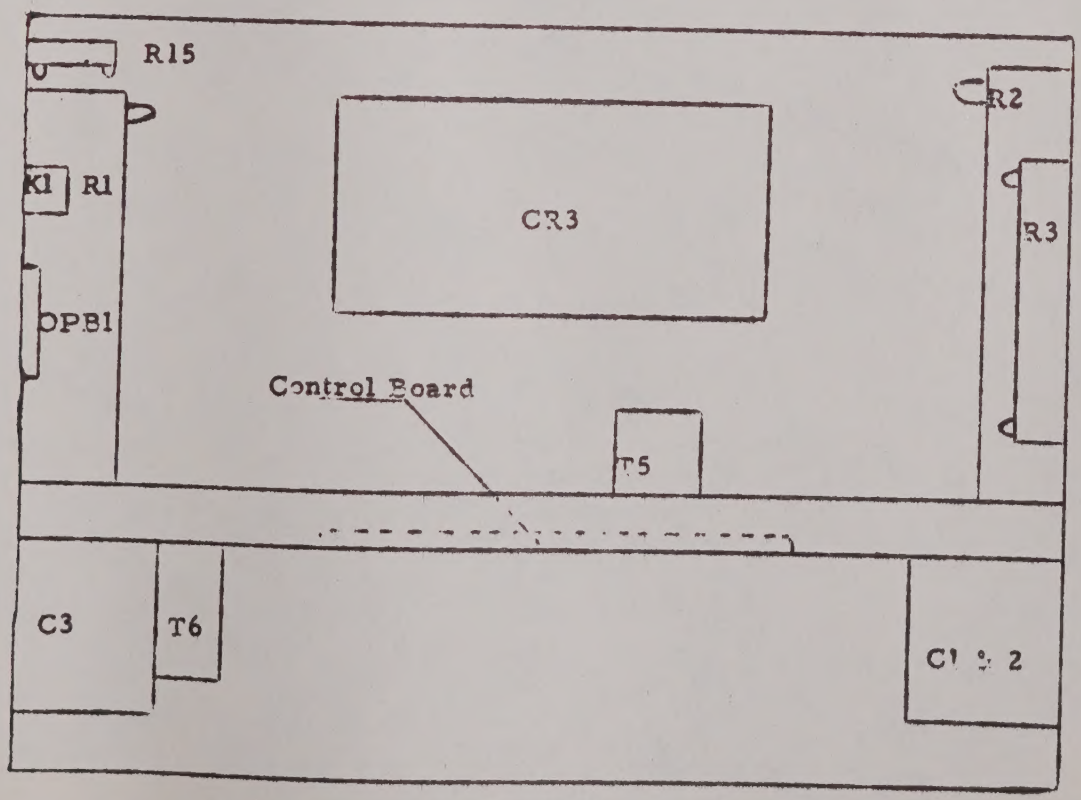
CAUTION: DANGEROUS VOLTAGES EXIST IN THIS INSTRUMENT. BEFORE TOUCHING ANY INTERNAL PART, MAKE SURE THAT THE INPUT POWER HAS BEEN DISCONNECTED BY AN EXTERNAL SWITCH.

Trouble Shooting

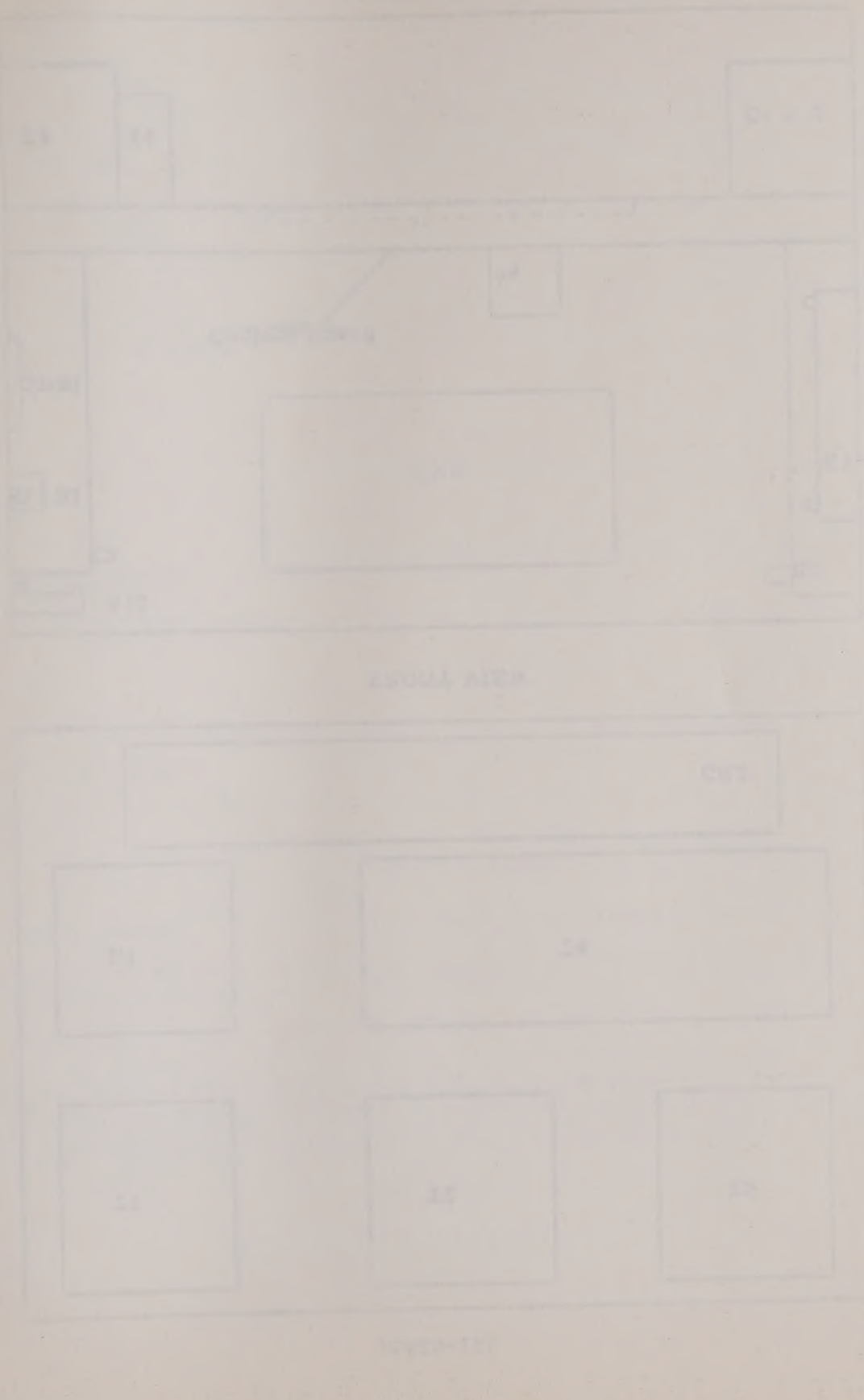
Symptom	Likely Cause	Procedure for Repair
No Output Voltage	Circuit Breaker or Main Fuse Open	Replace fuse Reset Breaker
	Open Power or Filter Circuit	Check for Open Circuit in T1-3, T4, CR2, L1, and Ammeter Shunt
High Output Voltage	Power Reference Failure	Check Power Reference per schematic and test voltages. Typical causes of failure could be failure of Q1-4, CR1 open, Q1 shorted is usual cause
Low Output Voltage	Open Fuse F1	Check Fuse F1
	Reduction of Blower Air	Check not actuated by Blower Thermostats & Relay
	Power Reference Failure	Check Power Reference per schematic and test voltages. Typical cause of failure could be failure of CR1, Q1-4.
High Ripple	Filter Circuit Failure	Check input line balance and mag-amp balance, Check capacitors C1-3, L1.
Poor Regulation	Failure of CR1	Check or Replace CR1
	Line Comp. Failure	Check R11 & 16 for continuity.

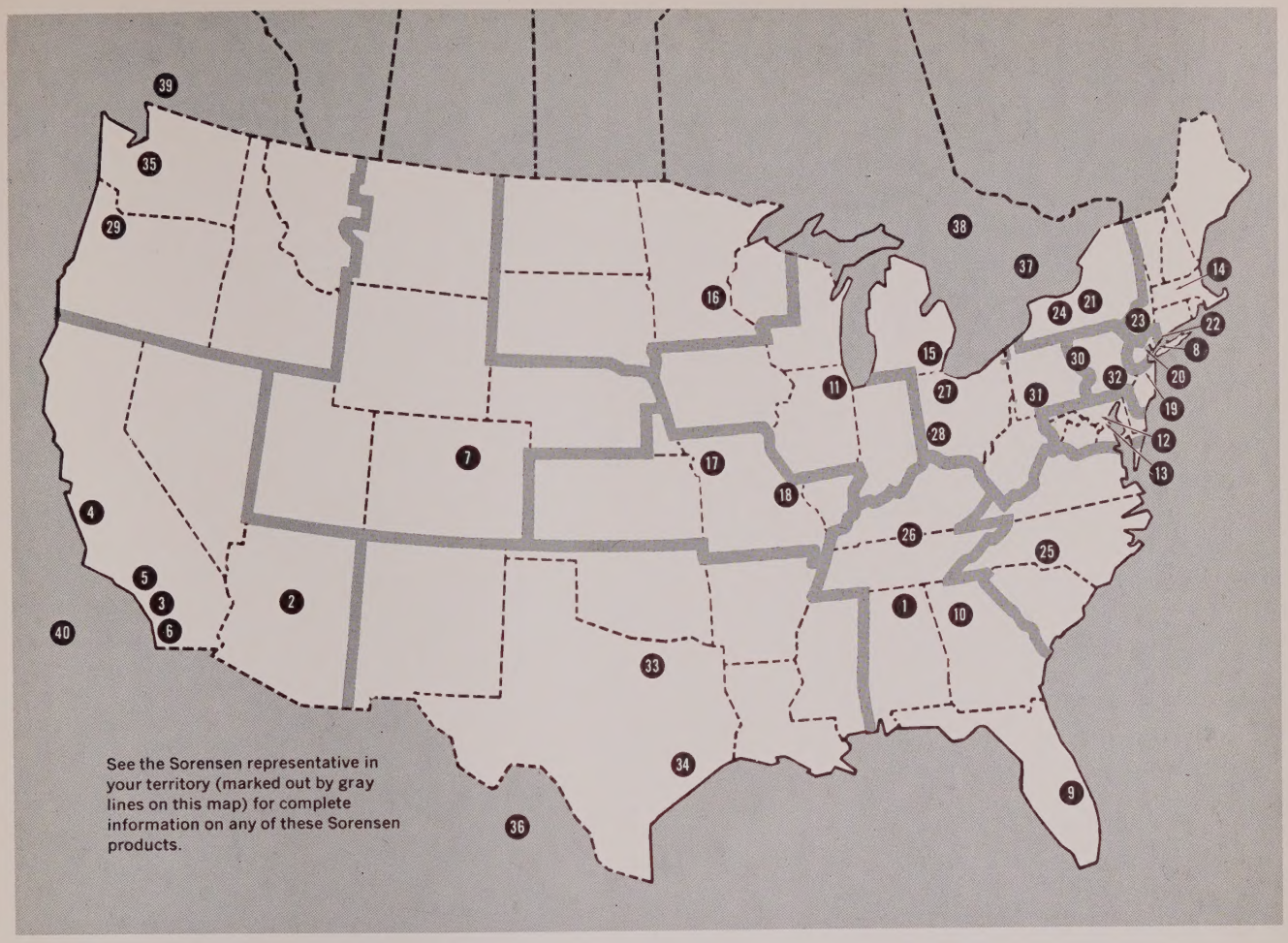


FRONT VIEW



BACK VIEW

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